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MINISTRY OF INTERNATIONAL TRADE AND COOPERATION

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THE STUDY
ON
THE KOK-ING-NAN WATER DIVERSION PROJECT
IN
THE KINGDOM OF THAILAND

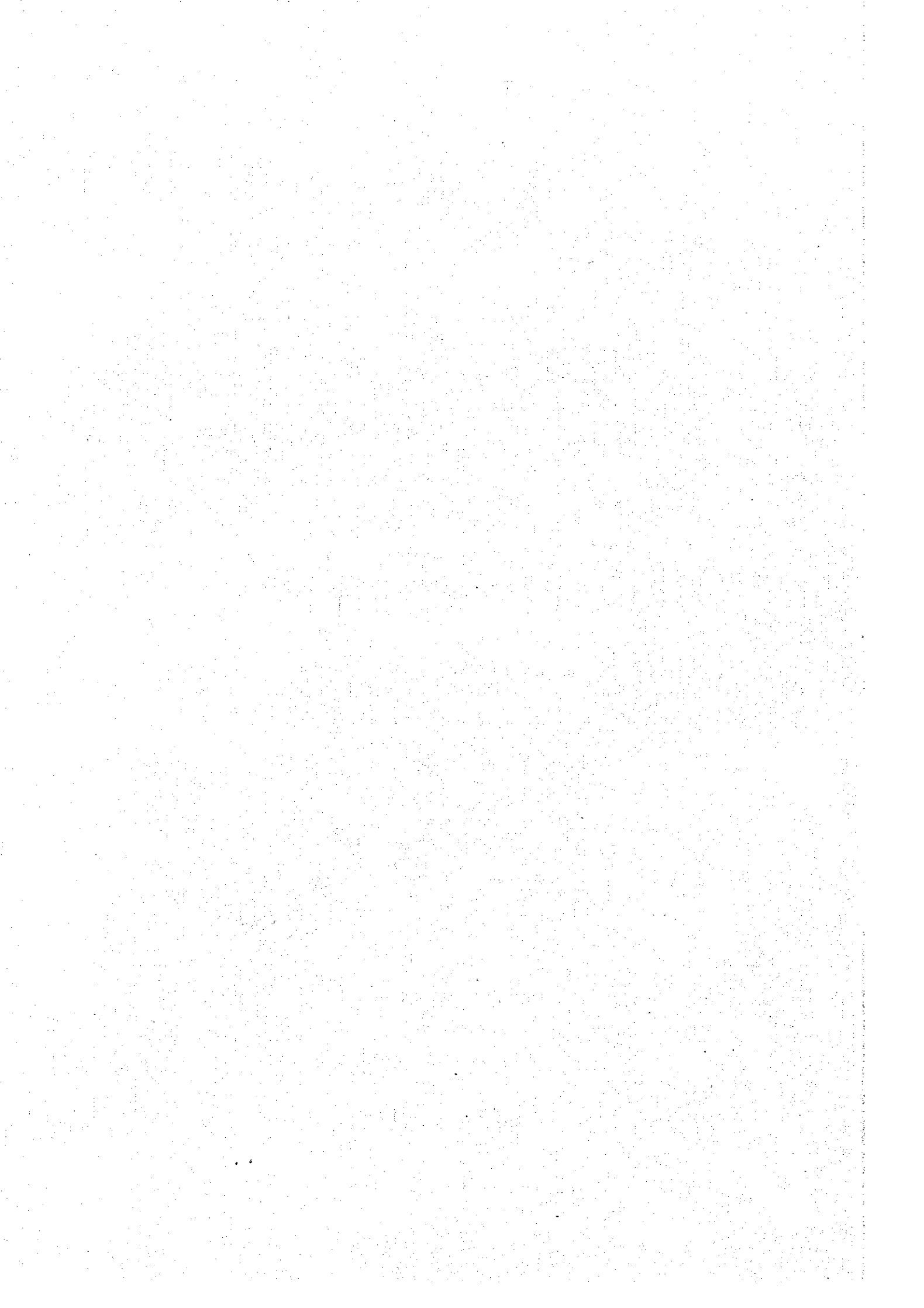
SUPPORTING REPORT

(Initial Environmental Examination)

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JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)

ROYAL IRRIGATION DEPARTMENT
MINISTRY OF AGRICULTURE AND COOPERATIVES
THE KINGDOM OF THAILAND

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MARCH 1997

SANYU CONSULTANTS INC.
NIPPON KOEI CO., LTD.

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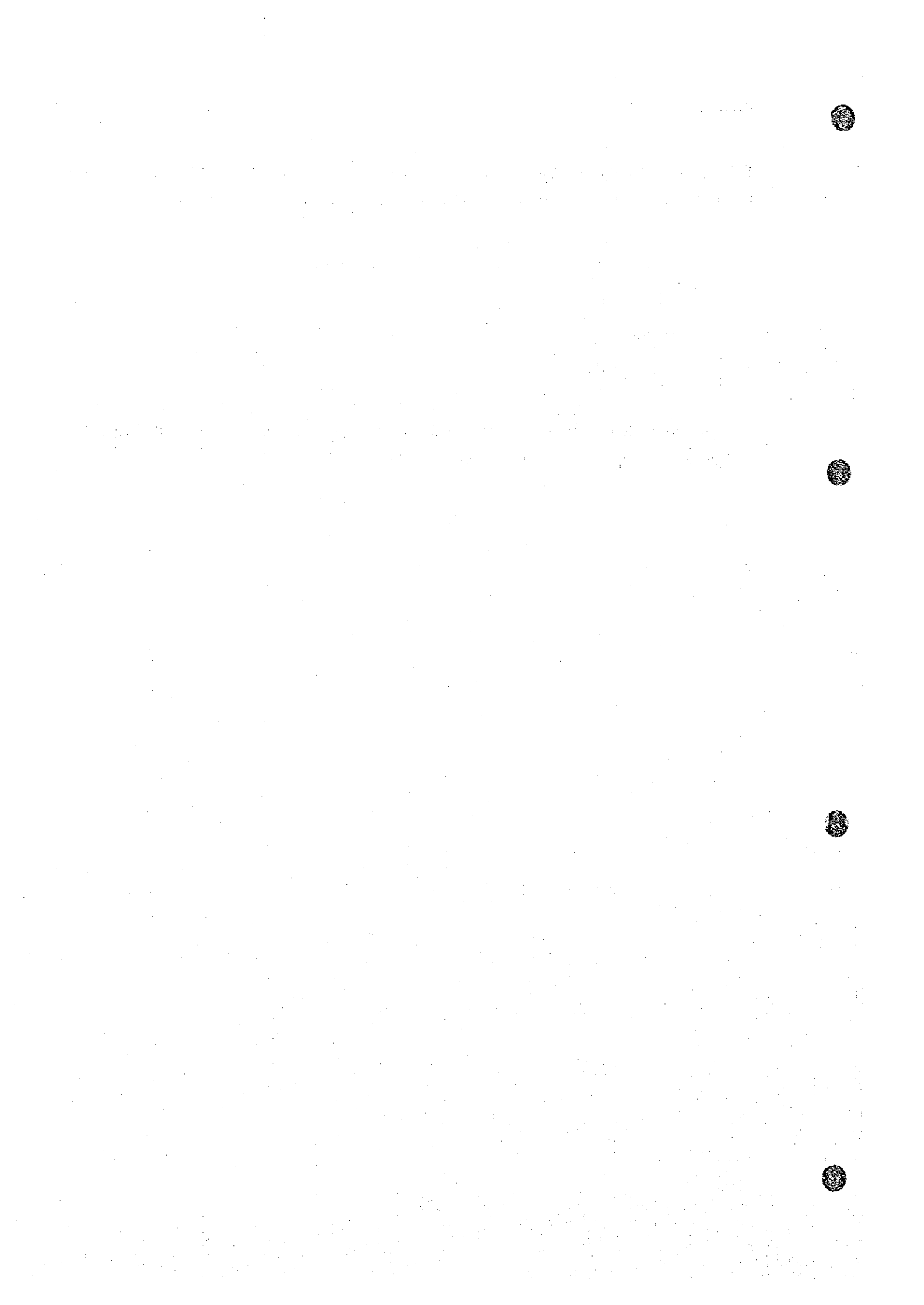
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Preface

The Supporting Report (this Volume) constitutes a part of the Initial Environmental Examination on the Kok-Ing-Nan River Diversion Plan, which composes the followings;

- Summary Report (Part II Initial Environmental Examination)
- Main Report
- Supporting Report
- Database Map

The Supporting Report is compiled based on the environmental study done by the TEAM J/V consultants under the contract with the RID.



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CHAPTER 1 FORESTRY

1.1 Forestry and Environmental Resources in the Project Area

The names and areas of the national forest reserves in the Kok Basin, the Ing Basin and the Nan Basin are shown in Table 1.1, 1.2, and 1.3 respectively.

Forestry

The Kok basin area covers an area of about 10,875 sq.km in 8 Amphoes and 2 King-Amphoes of Chiang Mai Province and Chiang Rai Province. There are 3 National Forest Reserves out of 23 under Changwat Chiang Mai, with an area of 1,012,031 rai covering this basin. The basin is also under the Chiang Rai National Forest Reserves in 15 forests out of 30, with an area of 2,169,354 rai or 69 percent of the Nam Kok Basin.

The total area of the Ing Basin is approximately 7,388 sq.km covering Phayao Province and Amphoe (District) Chiang Khong, Chiang Rai Province. The Basin lies under 29 National Forest Reserves with an area of 2,560,281 rai or 55 percent of the total areas of the basin.

The Nan Basin covers an area of about 34,300 sq.km. in the provinces of Nan, Utradit, Petchabun, Pitsanulok, Pichit and Nakhonsawan. There are 66 National Forest Reserves with a total area of 19.3 million rai, out of which 13.7 million rai are conservation forests, 5.0 million rai are economic forest and only 0.6 million rai are classified as the area suitable for agriculture.

Environmental Resources

The forestry and environmental resources in the areas around the planned diversion structure sites in the Kok River and the Ing River are summarized as follows for alternative cases.

Environmental Resources	Alternative A	Alternative B/C
<u>Diversion Structure site in the Kok River</u>		
Ecosystem condition around the diversion structure site	Mainly agricultural areas, especially rice field and maize. No forest area.	Mainly agricultural areas, near Huai Mae Gorn which flows to Nam Mae Kok. No forest area.
Natural forest tree covering the construction area	The area on both sides of Nam Kok at this site is covered with giang mimosa. No forest tree species.	No forest trees in this area. There are only giant mimosa along both sides of the river.
<u>Diversion Structure Site in the Ing River</u>		
Ecosystem condition around the diversion structure site	Mainly agricultural areas, especially rice field and maize. In the vicinity of the site, degraded Mixed Deciduous and Dry Dipterocarp forest were found.	Mainly agriculture areas i.e., paddy field.
Natural forest tree covering the construction area	The natural tree species in this area, are: Shorea siamensis (Rung), Shorea obtusa (Teng), Afzelia xylocarpa (Makka), Pterocarpus macrocarpus (Pradu), Xylia xylocarpa (Daeng), Spondias pinnata (Makok)	No forest trees in the area adjacent to the proposed dam site.

Figure 1.1 shows a classification of forest areas and the route alignments of the canals and culverts under alternatives A, B and C. Figure 1.2 presents a watershed classification of the project area and the proposed route alignments of the three alternatives.

The impacts of the Kok-Ing-Nan project on the environment along the diversion canals and culverts are summarized as follows for the Kok River to the Ing River portion and the Ing River to the Nan River portion for each alternative case.

Environmental Aspects	Alternative A	Alternative B	Alternative C
Along the Diversion Canal/Culverts and Tunnels from Nam Kok to Nam Ing			
Disturbance to the forest reserves	The diversion canal and tunnel from Mae Kok to Mae Ing will pass 5 national forest reserves in zone C for a distance of about 12 km, and zone E for a distance of 4 km. Most of these sections pass underneath the mountain.	The diversion canal and tunnel from Mae Kok to Mae Ing will pass 5 national forest reserves in zone C for a distance of 4 km and zone A for 2.5 km each. National forest would be slightly disturbed because the diversion structure at those sections mostly pass underground, not lower than 500-1,000 m from ground surface.	Same as alternative B.
disturbance to watershed class 1 areas	Tunnel will pass underneath watershed class 1 areas, with a distance of about 2 km.	Neither canal nor tunnel will pass through watershed class 1 area.	Neither canal nor tunnel will pass through watershed class 1 area.
Forest conditions	The canal passes mainly through the rice field and upland crops areas. Mixed Deciduous and Dry Dipterocarps Forests are scattering and bamboos were found near the tunnel inlet.	Areas to be destroyed are mostly agriculture areas. The areas at the tunnel inlet and outlet are sloping hillside or hillfoot covered mostly with upland crops. Remaining forest areas are small in area.	Same as alternative B.
Size of forest areas to be disturbed	About 100-200 rai of degraded forest will be affected.	Forest area of about 100 rais will be affected.	About 100 rai of degraded forest will be affected.
Along the Diversion Canal/Culverts and Tunnels from Nam Ing to Nam Nan (Yod)			
Disturbance to the forest reserves	Most of the alternative A route is tunnel which will pass beneath 3 national forest reserves in the forest conservation zone (C) for 56.61 km and the economic forest zone (E) for 0.54 km.	The diversion tunnel of alternative B will pass beneath 3 national forest reserves in the forest conservation zone (C) for 56.61 km and the economic forest zone (E) for about 0.54 km.	The tunnel will pass beneath 9 national forest reserves in the forest conservation zone (C) for 34.46 km, the economic forest zone (E) for 3.39 km and the forest land suitable for agriculture for 3.57 km.
Disturbance to watershed class 1 areas	The diversion tunnel of alternative A will pass underneath WC1 about 29.70 km.	The diversion tunnel of alternative B will pass underneath WC1 about 27.0 km.	The diversion tunnel of alternative C will pass underneath WC 1 about 16.30 km.
Forest conditions	The alternative A route will pass through agricultural land and degraded forest.	The alternative B route will pass through agricultural land and degraded forest.	Same as Alternative A and B.
Size of forest areas to be disturbed	About 700-800 rai of degraded forest will be affected.	About 400-500 rai of degraded forest will be affected.	About 300-400 rai of degraded forest will be affected.

1.2 Preliminary Impacts Assessment

Most of the area that the water diversion canals of alternatives A, B and C, will pass through are agricultural lands such as rice field, corn, cane and the shifting cultivation areas. The areas of inlet/outlet and inclined shaft are covered with the degraded forest which have been encroached by the local people for agricultural purpose. The diversion tunnel section that will pass under the conservation areas such as the national forest reserves, the forest conservation zone and watershed class 1 (WSC1) will not disturb the forest community because the diversion tunnel will pass underground with more than 500-1,000 m depth. Some inclined shafts of alternative A and B may disturb the area of WSC1, but those areas are degraded forest. The impact on forest resource, therefore, is expected to be minimal.

Since the Kok-Ing-Nan Diversion Project partly affects the watershed class 1, an environmental impact assessment (EIA) report will be required to be submitted to the National Environmental Board (NEB). After the NEB's approval of the EIA report, it will be submitted to the cabinet for final approval.

1.3 Environmental Mitigation Measures Recommended for the Kok-Ing-Nan Project

Possible environmental problems and mitigation measures are proposed as follows.

Problems/Important Impacts	Recommended Mitigation Measures
Loss of forest area by the construction of canal/culvert and tunnel for water diversion.	The construction should not be carried out in forest reserve area; if it cannot be avoided, cut as few trees as possible and reforestation should be made properly. In the event that construction has to be carried out in reserved forest area, permission has to be obtained from the Royal Forestry Department (RFD) according to law and regulations; a plan to compensate forest land lost because of the construction has to be prepared and approved by RFD.
Disturbance of the Watershed Class 1 area (WSC1)	No activities are allowed in WSC1 area; If this cannot be avoided, the activities have to follow laws and regulations strictly and an EIA needs to be made for an approval of the National Environmental Board. The EIA will further be submitted to the cabinet for approval resolution.
Forest land adjacent to the construction site being illegally occupied by project's workers/officials and local villagers.	Workers' camp or community should not be built close to forest area. Project's workers/officials and villagers should not be allowed to encroach into forest area and/or hunt by issuing regulations and enforcing them strictly.

1.4 Further Study Items Required Before EIA

To supplement the initial environmental examination at this preliminary phase before the EIA, further investigation on the following items are needed.

- a) **Preliminary Impact Assessment on the Nan watershed area:** Some impacts are expected by the flood control dam and Yao River training.
- b) **Preliminary Impact Assessment on the vegetation around the Phu Sang Waterfall:** This waterfall is the only hot waterfall in Thailand.
- c) **Investigation on each forest type (natural forest, secondary forest, degraded/deforested area, recovering forest area) in the Kok, Ing and Nan basin:**
 - distribution
 - vegetation type, biological characteristics, biodiversity, ecosystem
 - forest production
 - utilization of the forest
 - management plan for utilization and conservation of the forest
 - meteorological condition
 - soil condition

Table 1.1
National Forest Reserves of the Kok Basin

No.	Name of the Forest	Amphoe (District)	Area (Rai)
<u>Chiang Mai Province</u>			
1.	Mae Fang Forest	Fang	1,000,000
2.	Mae Lak Muen Forest	Fang	8,125
3.	Mae Soon Forest	Fang	3,906
<u>Chiang Rai Province</u>			
1.	Pong Salee Forest	Muang	668
2.	Mae Khao Tom and Huai Luk Forest	Muang-Mae Chan	15,362
3.	Huai Sak-Right Bank of Mae Kok Forest	Muang-Wiang Chai	191,250
4.	Left Bank of Mae Lao Forest	Mae Suay	710,937
5.	Right Bank of Mae Lao Forest	Wiang Pa Pao	124,375
6.	Doi Bo Forest	Muang-Mae Chan	149,185
7.	Right Bank of Sob Kok Forest	Mae Chan-Chiang Saen	265,725
8.	Right Bank of Mae Lao Forest	Mae suay	169,437
9.	Left bank of Mae Lao and Right Bank of Mae Kok Forest	Muang	203,125
10.	Doi Pui Forest	Muang	91,875
11.	Nam Ma and Sob Ruak Forest	Chiang Saen	12,028
12.	Mae Poon Noi, Mae Poon Luang & Huai Pong Men Forest	Wiang Pa Pao	398,750
13.	Nam Mae Kam, Nam Mae Salong & Left Bank of Mam Mae Chan Forest	Mae Chan	353,750
14.	Doi Nang Lae, Doi Yao & doi Prabat Forest	Muang	132,100
15.	Doi Thum Pha Tong, Doi San Pakoi & Nam Ngam Forest	Muang	38,475

Note: 1 Rai = 0.16 ha

source: Chiang Rai and Chiang Mai Forest Regional Office

Table 1.2
National Forest Reserves of the Ing Basin

No.	Name of the Forest	Area (Rai)	Percent
1.	Right Bank of Mae Khong Forest	9,133	0.36
2.	Right Bank of Mae Sob Kok Forest	40,341	1.58
3.	Nam Maa and Nam Chang Forest	54,453	2.13
4.	Doi Khanun & Nam Yaeng Forest	6,392	0.25
5.	Huai Sak & Right Bank of Nam Kok Forest	131,038	5.12
6.	Doi Luang, Nam Yao & Nam sor Forest	132,812	5.19
7.	Khun Huai Ngiw, Chiang Kian & Khun Huai Pong Forest	298,828	11.67
8.	Right Bank of Mae Ing & Mae Ngao Forest	64,530	2.52
9.	Huai Pa Daeng, Huai Pa Taan & Huai Krai Forest	124,743	4.87
10.	Left Bank of Nam Ngao Forest	106,250	4.15
11.	Doi Taa & Doi Bo Som Forest	20,000	0.78
12.	Doi Pui Forest	28,008	1.09
13.	Huai Ton Yaang & Huai Kaew Forest	50,000	1.95
14.	Right Bank of Mae Lao, Mae Saan & Mae Chai Forest	170,625	6.66
15.	Mae Pum & Mae Poong Forest	169,087	6.60
16.	Mae Pum & Dong Pradu Forest	31,000	1.21
17.	Huai Bong Po, Huai Kian Forest	34,737	1.36
18.	Mae Hong Po, Huai Kaew & Left Bank of Mae Ing Forest	75,450	2.95
19.	Mae Loi Rai, sak Lo & Nam Poong Forest	93,750	3.66
20.	Doi Bo Som & Doi Pong Nok Forest	28,125	1.10
21.	Nam Peai, Nam Yuan & Nam Lao Forest	269,022	10.51
22.	Nam Van & Huai Krai Forest	86,250	3.37
23.	Mae Choon Forest	104,063	4.06
24.	Dok Khem & Right Bank of Ing Forest	98,750	3.86
25.	Mae Yom Forest	9,802	0.38
26.	Mae Rong Sui Forest	71,614	2.80
27.	Mae Tum Forest	99,551	3.89
28.	Mae Tum and Mae Na Rua Forest	148,407	5.80
29.	Doi Muan Poo Mao & Muan Hin Yao Forest	3,502	0.14
Total		2,560,263	100.00

Note: 1 Rai = 0.16 ha

Table 1.3
The National Forest Reserves of Nan Basin and Some Parts of Adjacent Basin

Province	Conservation Zone		Economic Zone		Area Suitable for Agriculture		Total	
	Area(rais)	%	Area(rais)	%	Area(rais)	%	Area(rais)	%
Nan	5,998,450	87.75	812,133	11.88	25,150	0.37	6,835,733	100.00
Uttaradit	2,681,325	81.19	621,250	18.81	0	0.00	3,302,575	100.00
Pitsanulok	1,953,492	61.40	1,228,053	38.60	0	0.00	3,181,545	100.00
Pichit	0	0.00	137,235	95.49	6,475	4.51	143,710	100.00
Petchabun	2,613,740	56.49	1,749,018	37.80	263,875	5.70	4,626,633	100.00
Nakhorn Sawan	460,175	9.95	508,550	10.99	257,175	5.56	1,225,900	100.00
Total	13,707,182	70.96	5,056,239	26.18	552,675	2.86	19,316,096	100.00

Source : Master Plan and Implementation Plan for Environment and Watershed Rehabilitation , Environmental Policy and Planning Office , 1995

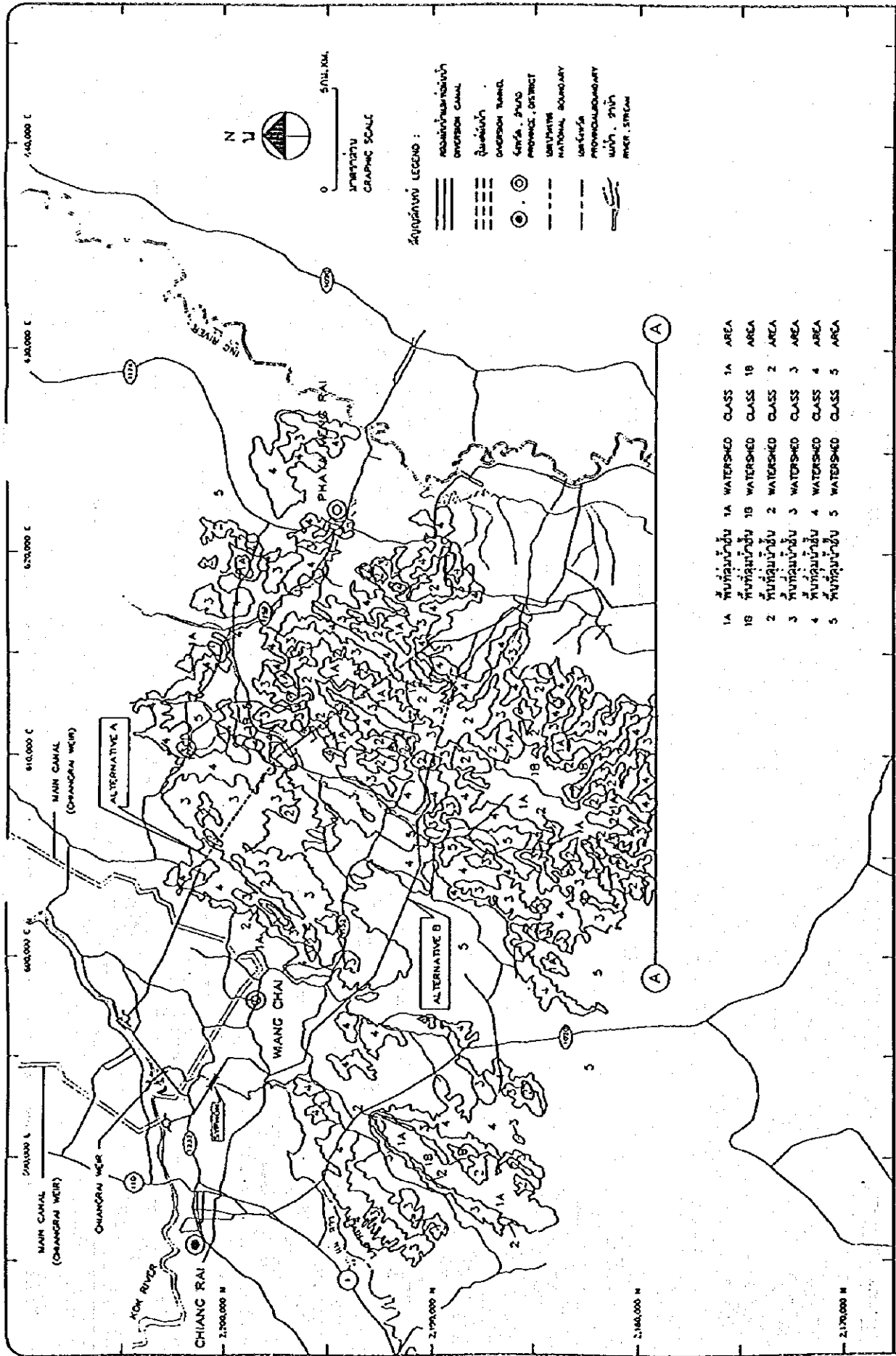


Figure 1.2 Watershed Classification Area and Proposed Route Alignment of Canals and Culverts under Three Alternatives (1/2)

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CHAPTER 2 WILDLIFE

2.1 Objectives

An analysis on wildlife was carried out to assess possible impacts of the project implementation and selection of alternative diversion channel. The objectives are as follows:

- 1) To gather information on species, abundance and status of the wildlife existing in the project area and vicinity.
- 2) To analyze the existing ecology of the project area related with wildlife.
- 3) To analyze trend in ecological changes and assess possible impacts of the project implementation on wildlife.

2.2 Methodology

The analysis focuses on four groups of wildlife, namely amphibian, reptile, bird and mammal. The information on these wildlife were collected in the following manner.

- a) Diversion canal and/or culvert: for the area of 1,000 m long and 200 m wide selected along the proposed diversion canal and culvert with an interval of 3 km from each plot.
- b) Diversion tunnel: within a 1 km² area at the tunnel inlet, outlet and shaft.

The survey comprised the following works:

- a) The investigation was aimed to gather information on wildlife in the areas of the project components. Frequency of a particular wildlife species found was recorded to estimate its abundance. For the most accurate surveyed information of wildlife, direct and indirect counts were applied.
- b) Ecology of the project area was studied by gathering the information relating to food source, water resource, breeding source, and hiding location in order to identify the suitability and fertility of wildlife habitat facilitating its survival. Information were collected on species, abundance and diversification of wildlife existing in the project area. The study classified wildlife groups with regard to their shelters like dense forest or dense vegetation. Some aquatic animals could survive in agricultural area while some could adapt to the community.
- c) Documents on wildlife verification referred to with regard to wildlife of Thailand include the

following.

- Amphibian: Taylor (1962)
 - Reptile: Taylor (1963, 1965, 1970), Nuttaphand (1979), and Cox (1991)
 - Bird: King et al. (1975) and Lekagul and Round (1991)
 - Mammal; Lekagul and McNeely (1977).
- d) Direct count and inquiry were made in the project area in order to list wildlife of a particular group and to identify abundance, status and form of impacts to be encountered.
- e) The level of abundance of wildlife was classified, in relative term, into "abundant", "common" and "less common". Frequency of wildlife found in the survey was calculated applying the equation of Pettingill (1970).
- f) The status of wildlife was judged according to the acceptable standard of Thailand under the determination of Humphrey and Bain (1990) and IUCN (1990), by which four conditions of wildlife are specified, i.e., "endangered", "vulnerable", "rare" and "indeterminate" status.
- g) Wildlife expected to be affected by the project implementation was classified into 3 groups:
- Those to suffer from negative impact and cannot adapt themselves to new habitat within the project area due to the ecological changes.
 - Those to obtain benefits from the project.
 - Those that can be adaptable to the changing condition of the project area both during the project construction and operation.

2.3 Results

2.3.1 General Condition

The survey referred to a report on the environmental impact analysis of the 115 kv transmission system project prepared as part of the Interdisciplinary Graduate Programme in Environmental Science, Kasetsart University (1993). The transmission line runs in the vicinity of the proposed diversion canals and tunnels for a distance of 50 km. The report revealed 44 wildlife species out of 210 species residing in the project area, which would be adversely affected by the project. They are 10 species of mammal, 26 species of bird, 4 species of reptile and 4 species of amphibian as shown in Table 2.1. The study area and its vicinity are mostly agricultural areas with plantation and dry dipterocarp forest as well as mixed deciduous forest in some areas. Most of the wildlife living in the project area are small animals capable to adapt themselves to the destroyed environment. The only "threatened species" found is bengle monitor (*Varanus bengalensis*). No other rare or endangered species was found.

Srikosamatara (1994) reported that the overall wildlife status along the Thai-Lao border area in the north is not so good since this area was reached by many roads and encroached by shifting cultivation on the mountainous areas.

2.3.2 Result of Direct and Indirect Counting

(1) Wildlife Condition along the Diversion Canal / Culvert

(a) Diversion Canal / Culvert in Kok-In Area

Alternative A: Four groups of wildlife, amphibian, reptile, bird and mammal were found. Most of the wildlife living in the project area are small and capable to adapt themselves to disturbance, agricultural and village community areas. The majority of them are birds which earn their living in open areas such as rice field. The two biggest size mammals, found in the preliminary survey were Siamese hare (*Lepus preguensis*) and common civet (*Paradoxurus hermaphroditus*).

Alternative B: Four groups of wildlife of almost similar species as those of the alternative A were found. Most diversion route will pass through plain area except a few sections passing through sloping areas and mountains covered with dry dipterocarp forest and cultivation area. The remaining area is low land covered with grass or small swamp during wet season.

Alternative C: Four groups of wildlife were found. Most of them are similar to those found in the alternative B. Bird is the majority of them.

The areas along the diversion routes of the open diversion canal/culvert of the alternative A, B, and C area and nearby areas are open area with scattering big trees and cultivated land with some abandoned areas which could be used for agricultural purpose. The agricultural areas are rainfed rice field. Farmers in many areas burn paddy stubbles in dry season which affects living area of wildlife and continuously disturbs the ecological system. The survivors are those with the ability to adapt themselves to the constant changes of ecology and earn their living on the ground or in bush trees. The size of those wildlife is normally small with active movement, especially bird. Other groups found include reptile living on the ground, small size mammal like Siamese hare (*Lepus peguensis*), Common Civet (*Paradoxurus hermaphroditus*) and rats. The reptiles found in the survey were in the groups of Lizard, and Snake. Most of the amphibians found were those benefiting from rice field such as Lowland Frog (*Occidozyga lima*), Marsh Frog (*Rana limnocharis*), Common Lowland Frog (*Rana rugulosa*), Paddy-field Puddle Frog (*Phrynoglossus martensii*), etc. Rice field nearby water resources usually has high moisture and pounded area, while rice field in other areas would have such ecological profile during

rainy season only.

(b) Diversion Canal / Syphon in Ing-Nan Area

The dominant situation of wild life along the diversion canal/culvert in the Ing-Nan area is similar to that found in the Kok-Ing area. The amount of species found in the Ing-Nan area, however, was smaller than that found in the Kok-Ing due to shorter distance of the proposed canal/culvert in the Ing-Nan portion.

(2) Wildlife Situation Around The Tunnel Inlet / Outlet

(a) Kok-Ing Area

Alternative A: The alternative A will comprise 2 sections underneath the mountain with each having an inlet and an outlet totalling four excavation areas. An overall ecological profile is sloping hillside and/or hillfoot. These areas used to be mixed deciduous forests, which were later turned into crop cultivation area of upland crops such as corn. Some areas are covered with weeds. Bamboo was abandoned. The inlet/outlet areas of the tunnel section 1 are rice fields.

Alternative B and C: This route will comprise only 1 section underneath the mountain. Excavation, therefore, will be made at two locations, at the tunnel inlet and the tunnel outlet. These areas are slope hillside and/or slope hillfoot. Crop cultivation, mostly corn, is performed in these areas. The area used to be mixed deciduous forests and covered with bamboo in some areas.

The wildlife found in the survey was those of small size and able to adapt themselves to disturbed area or constantly changing environment. Those wildlife found were in 4 groups, namely amphibian, reptile, bird and mammal, of which the biggest size found was Large Indian Civet (*Viverra zibetha*) at the area of tunnel outlet of the alternative B. Some birds like Red Jungle fowl (*Gallus gallus*), White-rumped shama (*Copsychus malabaricus*), Greater racket tailed drongo (*Dicrurus paradisens*), etc. were also observed in this area. These species usually live in forest community where cluster of mixed deciduous forest remains and bamboo is vegetated.

(b) Ing-Nan Area

Tunnel Inlets of Alternative A and B: The areas around the tunnel inlets of the alternative A and B are cultivation area. Farmers apply chemical pesticide and grub the area when cropping season comes. The area nearby has the similarity to the Kok-Ing area. Wildlife found were those being well adaptable to

changes and disturbance. Those wildlives are usually of small size with active movement. They are not much diversified in population. No big one was observed or recorded in the area since the remaining vegetation is not dense enough for hiding. Most of the wildlife species found were birds and reptiles like lizard and snake. Local people informed us that Large Indian Civet (*Viverra zibetha*), the biggest mammal in this area, was observed.

Tunnel Inlet of Alternative C: The area of the tunnel inlet is a huge hill covered with dispersed dry dipterocarp forest community with no crown canopy. Local people informed us that wild fire breaks out every dry season. The surrounding area is rice field. Perennial trees and plant community in the forest area are not dense enough for big size wildlife species to live. Besides, few forage plants are available in the area. Some areas were found to be used as transportation routes for mushroom gathering and animal raising and rice field along the hill channel. Small size wildlives such as mammal like Siamese hare (*Lepus peguensis*), Javan mongoose (*Herpetes javanica*) Grey-bellied Squirrel (*Callosciurus caniceps*), Common tree shrew (*Tupaia glis*) and rat were found in small number. Some insectivorous birds, reptile like lizards and snakes and some amphibians are found living nearby and/or in the small scale water resources with temporary ponding area during rainy season along hilly area and in rice field.

Tunnel Outlets of the Alternative A, B and C: Environment in this area was disturbed through the maintenance, cultivation and grubbing for cropping. Some open areas are used as fruit orchard. There were only a small-size wildlife found. Active moving wildlife in this area are birds, rat, bat and some reptile group like lizard and snake. Big-headed turtle (*Platysteron megacephalum*) was reported in Huai Yod river by local people.

(3) Wildlife Situation Around Vertical Shafts

Alternative A and B

The area was grubbed for cropping with no forest community at present. Soil mulching is conducted for field crops during cropping season and dense weed grows after crop cultivation. Some areas are lychee orchards. The wildlife found are few and of small size, which are used to the disturbance caused by agriculture activities and able to adapt themselves to changes of the area. Some medium size mammals were reported to be found by local people such as common barking deer (*Muntiacus muntjak*) and Common wild pig (*Sus scrofa*). Big-headed Turtle (*Platysteron megacephalum*) was the only reptile in vulnerable status found in the Yuan River.

The diversion tunnels of the alternative A and B will be installed in the Ing-Nan area underneath the steep mountain between the Thai-Lao border where forest community such as mixed deciduous forest and dense forest exist. This area has been proposed to become Phu-sang National Park in the draft

Decree. The information of the official of the National Park and local people indicated that there are a number of wildlife species found in the forest community above the area planned for the shafts.

Alternative C

In this area constant cropping activities are found and there is no forest community. The forage plants are corn and rice from rice fields. Wildlife observed, therefore are those of small size which are able to hide themselves in the fields and/or weed community and make use of field crops as food source, available only in small amount. Birds and bats or those with active movement rodents like rats and some reptile in the groups of lizard and snake are found. Medium size mammals reported to be found by local people were Common Barking Deer (*Muntiacus muntjak*) and Common wild pig (*Sus scrofa*) migrating from the mountain downward to the area of shaft 3, 4 and 5 area from time to time.

2.3.3 Preliminary Impact Assessment

(1) Impact to be generated by Project Activities

Impacts of the project on wildlife were analyzed for construction and operation stages.

Regarding tree cutting, area grubbing and construction works, the survey revealed that 44 species of wildlife be affected through the destruction of their habitat and food source as well as ecological change. Some wildlife would be hunted during area grubbing and tunnel excavation. After the completion of tunnel construction, wildlife would be affected by roads constructed across their habitat. These wildlife could be classified into 4 species of amphibian, 4 species of reptile, 26 species of bird and 10 species of mammal with the following details:

- a) The four species of amphibian are Common brown (*Rana nigrovittata*), Aquatic frog (*Rana kuhlii*), Common stream frog (*Rana pileata*) found only in alternative A and B and Truncate Snout (*Glyphoglossus molossus*). Common brown frog and Aquatic frog live on the banks of the stream flowing through dense forests with rocks, while Truncate snout Burrowing frog lives in burrow within forest area.
- b) The four species of reptile found in all alternatives are Big-headed turtle (*Plytysteron megacephalum*), Elongate tortoise (*Indotestudo elongata*), Orange-winged flying lizard (*Droco maculatus*), and Forest lizard (*Calotesemma*). Elongate Tortoise live in lower forest area, while Orange-winged flying lizard and Forest lizard live on the tree trunk in forest area. Big-headed turtle lives in the stream running through the forest area. Elongate tortoise would be hunted.
- c) The 26 species of bird are Crested serpent eagle (*Spilornis cheela*), Crested Goshawk (*Accipiter*

trivigatus), Collar falconet (*Microhierax caerulescens*), Red Jungle fow (*Gallus gallus*), Red breasted parakeet (*Psittacula alexandri*), Vernal hanging lorikeet (*Loriculus vernalis*), Brown-fish owl (*Kelupa zeylonensis*), Green-eared barbet (*Megalaima faiostriata*), Dollarbird (*Eurystomus orientalis*), Great barbet (*Megalaima virens*), Speckled piculet (*Picumus innominatus*), Large cuckoo-shrike (*Coracina macei*), Bar-winged Flycatcher-shrike (*Hemipus picatus*), Scarlet Minivet (*Pericrocotus flammeus*), Golem-fronted leafbird (*Chloropsis aurifrons*), Blue-winged leafbird (*Chloropsis cochinchensis*), Velvet-fronted nuthatch (*Sitta frontalis*), Long-tailed sibia (*Heterophasia picaoides*), Black-headed bulbul (*Pycnonotus atriceps*), White-crested laughingthrush (*Garrulax leucolohus*), white-rumped shama (*Copsychus malabaricus*), Grey-headed Flycatcher (*Culicicapa ceylonensis*), Tickell's blue flycatcher (*Cyornis tickelliae*), Verditer flycatcher (*Eumias thalassina*), Black-naped monarch (*Hypothymis azurea*) and Hill myna (*Gracula religiosa*).

Among these 26 species, 10 species were not confirmed in the alternative C in this investigation. 9 species would be affected since they use burrow as their nest and to lay eggs. They were Red-breasted parakeet, Vernal hanging lorikeet, Green-eared barbet, Great barbet, Speckled Piculet, Brown-fish owl, Dollarbird, Collar falconet, Hill myna. Some species like Red jungle fow, Red-breasted parakeet, Hill Myna would be hunted.

d) The 10 species of mammals were Siamese hare (*Lepus peguensis*), Noisy rat (*Leopoldamys sabanus*), Malayan porcupine (*Hystrix brachyura*), Bamboo rat (*Canomys badius*), Large bamboo rat (*Rhizomys sumatrensis*), Common-palm civet (*Paradoxurus hermaphroditus*), Small Indian civet (*Vevericula indica*), large Indian civet (*Viverra zibetha*), Common wild pig (*Sus scrofa*), and Common barking deer (*Muntiacus muntjak*). All species would probably be hunted. Malayan porcupine was confirmed only in alternative C.

(2) Number of Wildlife Species to be Negatively Affected

Table 2.2 shows the numbers of wildlife species to be affected by the project operation. Table 2.2 shows that the operation of alternatives A and B, which excavate the diversion tunnel, would provide negative impacts on 43 species each, out of 207 and 210 species found during the survey along the alternative A and B respectively. 31 species out of 190 species found during the survey under the alternative C would be affected from the excavation work along the tunnel. Excavation of diversion canal/culvert would provide negative impacts on 2, 5 and 1 animals respectively. Wildlife species along the diversion canal/culvert of 3 alternatives to be affected are similar to those affected along the diversion tunnel. Excavation work for alternative B will provide negative impacts on more wildlife species than alternative A and C. Considering the operation of diversion tunnel only, the alternatives A and B will provide negative impacts on more wildlife species than the alternative C.

There will be one "threatened species" due to the project, which is Big-headed turtle (*Platysteron megacephalum*) found scatterly in the project area along the stream as shown in Table 2.3. Excavation of diversion tunnel at Ing-Huai Yod would create this situation.

(3) Extents of Negative Impacts

The extent of negative impact was assessed from the present status of wildlife and the specific conditions in habitat in the area to be affected. Wildlife was classified with regard to the extent of impact as shown in Table 2.3.

- 1) Major Impact: Big headed turtle is in "danger" status at present. This animal would be endangered due to the project, indicating the possibility of extinction.
- 2) Moderate Impact: Nine species of bird living in burrow of the tree would be likely to receive moderate negative impacts. Those are Red-breasted parakeet, Vernal hanging lorikeet, Great barbet, Gree-eared barbet, Hill myna, Speckled Piculet, Dollarbird, Brown-fish owl and Collar falconet.
- 3) Minor Impact: Thirty-four species of wildlife found scattering in the project area and in other areas of the country would receive only minor negative impacts. Those species are classified as 5 species of amphibian, namely Common Grown Frog, Aquatic Frog, Common Stream Frog and Truncate Snout, Burrowing Frog, 3 species of reptile, namely Elongate Turtle, Orange-winged Flying Lizard, and Forest Lizard, 17 species of bird, namely Greater Serpent Eagle, Crested Goshawk, Red jungle fowl, large cuckoo shrike, Bar-winged flycatcher-shrike, Scarlet minivet, Golden-fronted leafbird, Blue-winged leafbird, Black-headed bulbul, White-crested laughingthrush, White-rumped shama, Velvet-fronted nuthach, Long-tailed sibia, Verditer flycatcher, Tickell's blue flycatcher, Black-naped monarch, Grey-headed flycatcher, and 10 species of mammal, namely Siamese hare, Noisy rat, Malayan porcupine, bamboo rat, Large bamboo rat, Common palm civet, Small Indian civet, Large Indian civet, Common barking deer and common wild pig.

Measures for mitigating the possible adverse impacts on the wildlife are presented in Table 2.4.

Table 2.1 Wildlife Observed in Preliminary Survey (1/2)

Class	Common names and Scientific names	Note
Amphibian 4 Species	Common grown (<i>Rana nigrovittata</i>)	C Mi
	Aquatic frog (<i>Rana Kuhlic</i>)	C Mi
	Common stream frog (<i>Rana pileate</i>)	C Mi
	Truncate snout(<i>Glyphoglossus molossus</i>)	C Mi
Reptilia 4 Species	Big-headed turtle (<i>Plytysteron megasephalum</i>)	Δ
	Elogate yurtouse (<i>Indotestudo elongata</i>)	Δ Mi
	Orenge-winged flying lizard (<i>Dorco maculatus</i>)	Δ Mi
	Forest lizard (<i>Calotesemma</i>)	Δ Mi
Aves 26 Species	Crested serpent eagle (<i>Spilornis cheela</i>)	C Mi
	Crested gosshawk(<i>Accipiter trivigatus</i>)	C Mi
	Collar falconet (<i>Microhierax caerulecens</i>)	C Mo
	Red jungle fowl(<i>Gallus gallus</i>)	Mi
	Red breasted parakeet(<i>Psitacula alexandri</i>)	Δ Mo
	Vernal hanging lorikeet(<i>Lariculus vernalis</i>)	Mo
	Brown-fish owl(<i>Ketupa zeylonensis</i>)	Mo
	Green-eared barbet(<i>Megalaima faiostrica</i>)	C Mo
	Dollarbird (<i>Eurystomus orientalis</i>)	Δ Mo (winter visitor)
	Great barbet(<i>Mygalaima virens</i>)	Δ Mo
	Spekled pinculet(<i>Picumnus innominatus</i>)	C Mo
	Large cuckoo-shrike(<i>Coracina macei</i>)	C Mi
	Bar-winged Flycatchert-shrike(<i>Hemipus picatus</i>)	C Mi
	Scarlet Minivet(<i>Pericrocotus flammeus</i>)	C Mi
	Golden fronted leafbird(<i>Chloropsis aurifrons</i>)	C Mi
	Blue-winged leafbird(<i>Chloropsis cochinensis</i>)	C Mi
	Velvet-fronted nuthatch(<i>Sitta frontalis</i>)	C Mi
	Long-tailed sibia(<i>Heteroohasia picaooides</i>)	C Mi
	Black-headed bulbul(<i>Pycnontos atriiceps</i>)	C Mi
	White-crested laughingthrush (<i>Gerrulax lencolophus</i>)	C Mi
White -rumped shama(<i>Copsychus malabaricus</i>)	C Δ Mi	
Gray-headed fly catcher(<i>Culcipapa ceylonensis</i>)	C Mi (passage in winter)	
Tickell's blue flycatcher(<i>Cyornis tickelliae</i>)	C Mi	
Verditer flycatcher (<i>Eumyias thalassina</i>)	C Mi (winter visitor)	
Black-naped monarch(<i>Hypothumis azurea</i>)	C Mi	
Hill Myna(<i>Gracula religiosa</i>)	C ΔMo(much reduced by capture)	

Table 2.1 Wildlife Observed in Preliminary Survey (2/2)

Class	Common names and Scientific names	Note
Mamalia 10 Species	Siamese hare (<i>Lepus peguensis</i>)	C Mi
	Noisy rat (<i>Leopoldamys sabanus</i>)	C Mi
	Malayan porcupine (<i>Hystrix brachyura</i>)	C Mi (not evidenced)
	Bamboo rat (<i>Canomys badius</i>)	C Mi
	Large bamboo rat (<i>Rhizomys sumatrensis</i>)	C Mi
	Common-palm civet (<i>Paradoxurus hermaphroditus</i>)	C Mi
	Small Indian civet (<i>Viverricula malaccensis</i>)	Δ Mi
	Large Indian civet (<i>Viverra zibetha</i>)	Δ Mi
	Common wild pig (<i>Sus scrofa</i>)	C Mi
	Common barking deer (<i>Mutiacus muntjak</i>)	C Mi

Note C: Common species
 Δ: species to be protected
 Mo: Moderate Affected
 Mi: Minor Impact

Table 2.2

Number of Wildlife Species to be Adversely Affected under Each Alternative

Group of Wildlife	Number of Species Affected					
	Alternative A		Alternative B		Alternative C	
	Diversion Tunnel	Diversion Canal	Diversion Tunnel	Diversion Canal	Diversion Tunnel	Diversion Canal
Amphibian	4	1	4	1	1	1
Reptile	4	1	4	1	4	-
Bird	26	-	26	1	16	-
Mammal	9	-	9	2	10	-
Total	43	2	43	5	31	1

Table 2.3

Number of Wildlife Species to be Negatively Affected by Status

Group of Wildlife	Number of Species Affected					
	Non-Threatened Species			Threatened Species		
	Alternative A	Alternative B	Alternative C	Alternative A	Alternative B	Alternative C
Amphibian	4	4	1	-	-	-
Reptile	3	3	3	1	1	1
Bird	26	26	16	-	-	-
Mammal	9	9	10	-	-	-
Total	42	42	30	1	1	1

Table 2.4

Number of Wildlife Species to be Negatively Affected Classified by the Extent of Impact

Group of Wildlife	Number of Species Affected								
	Major			Moderate			Minor		
	Alternative			Alternative			Alternative		
	A	B	C	A	B	C	A	B	C
Amphibian	-	-	-	-	-	-	4	4	1
Reptile	1	1	1	-	-	-	3	3	3
Bird	-	-	-	9	9	6	17	17	10
Manumal	-	-	-	-	-	-	9	9	10
Total	1	1	1	9	9	6	33	33	24

CHAPTER 3 WATER QUALITY AND AQUATIC ECOLOGY/FISHERY

3.1 Water quality

3.1.1 Methodology

The construction of the open canal/culvert and tunnel system will certainly create impacts on the water quality both during the construction and operation phases. The erosion during the construction caused by rain fall at the open construction site will increase the turbidity and suspended materials into the water sources. During the operation phase, the diversion of water from one watershed to other watershed may change characteristics of the receiving water.

Site investigations for water sampling sites were made in the middle of March, 1996. Water samplings were carried out in the following manner.

- a) Period : May 27 - 29, 1996
- b) Sampling sites : 10 stations as shown in Figure 3.1 (2 stations in the Kok River, 5 stations in the Ing Watershed and 3 stations in the Nan Watershed)
- c) Items analyzed :
 - physical parameter : transparency, flow rate, water temperature, velocity, depth, pH, conductivity,
 - chemical parameter : total hardness, dissolved oxygen, COD, BOD, nitrate, phosphate, ammonium, total solid, dissolved solid, suspended solid, chlorinate, sulfate
 - biological parameter : total coliform bacteria, fecal coliform bacteria
 - heavy metals : Pb, Cd, Cr, Hg, As, Ca, Mg, Fe, Mn
 - organochlorine : dieldrin, aldrin, BHC, heptachlor, endrin, DDT

3.1.2 Result

The result of the water sampling tests are presented as shown in Tables 3.1 through 3.3 in terms of ordinary water characteristics, the level of the heavy metal and pesticide.

Overall characteristics of the water sampled can be summarized as follows:

- The water in the Kok River (station 1 and 2) is rather turbid with high suspended solid levels.
- The water sampled are also slightly alkaline and soft.
- DO (dissolved oxygen) levels are high.
- BOD (biochemical oxygen demand) levels are very low.
- Inorganic nutrients in terms of total phosphate and ammonium are low.
- Coliform bacteria level is rather high especially at the station downstream of Chiangrai municipality.
- Heavy metals are low except iron.
- Pesticides in terms of organochlorine was not detected.

In the Ing Watershed, water samples were taken at the Mae Nam Loi, Huai Plong, Ing-Lao and Ing Rivers. It should be noted that during the sampling period there was almost no flow in the Huai Plong and the Mae Nam Loi rivers since both streams are small and villagers constructed their own weirs along the streams which stagnated the river. In the case of Ing-Lao River and Ing River, water flows were higher than in the Kok River. In this watershed water characteristics are quite similar to each other except turbidity. The following are the characteristics of the water in the Ing watershed.

- Small streams seem to be less turbid than big rivers.
- Water is quite soft.
- DO levels are higher.
- BOD levels are quite low in big rivers but rather high in case of Huai Plong and Mae Nam Loi, which run close to many small communities from which wastewater from villagers activities flow directly into the streams.
- pH levels are neutral.
- Both the total and fecal coliform levels are rather high.
- Heavy metals were rather low in all the stations.
- Pesticides was not detected from the samples.

The characteristics of the water sampled at the Nan Watershed are summarized as follows.

- Unlike other watershed, the water sampled at the Nan Watershed is rather clear.
- Suspended solid level are in a lower range because of no rain during the sampling period.
- Water is slightly alkaline and the hardness is higher than in other watersheds.
- Organic substances in terms of BOD are low.
- Nutrients and coliform bacteria are lower than in other watershed.

- Heavy metal and pesticide are very low.

Results from the first water sampling show that the characteristics of the water in the Kok River, the Ing River and the Nan River belong to class 2 according to the Ministry of Science, Technology and Environment classification. In case of all the streams such as Huai Plong and Mae Nan Loi, the water qualities are classified as class 4 due to higher BOD levels. Since the flows in these streams are quite small in quantity, they do not impose any serious impact on the water quality of the Ing River.

3.1.3 Comparison of Impact among Alternatives

A preliminary assessment was made on the impact of the three alternatives of A, B and C in the present Kok-Ing-Nan Project on the water quality. The following are the findings.

- In the Kok River, the alternatives B and C will comprise longer portions of open canal than the Alternative A. Instead Alternative A will comprise longer portions of tunnel. This difference will result in a higher level of sediment washed down from the construction site into streams and farther into the Kok River under Alternative A.
- There will be almost no difference between Alternative A and B in the Ing River and the Nan River at the construction phase.
- During the operation phase, the project will impose almost no impact on the water quality due to the similarity of water quality at the diversion site and the receiving water body.

3.2 Aquatic biology / Fishery

3.2.1 Methodology

The development of natural water resources can cause some impacts on the aquatic ecology and fishery resources. Some adverse effects can be solved or minimized if the activities of water resource development are within the same watershed. Water transfer and link with other watersheds may cause some impacts to the species composition and the abundance of aquatic organisms existing in the watershed. The purpose of the present survey is to evaluate the existing environment within the project sites with regard to the aquatic biology and fishery resources.

An analysis on aquatic biology and fishery was made in the following manner.

- Secondary data and information were collected and reviewed.
- Site investigation was carried out during March, 1996.
- During 26-29 May 1996, a field trip to the project site was made for collecting aquatic organisms.
- During the sampling period, fishing activities were observed and interviews made with local fishermen.
- The characteristics of aquatic organisms identified include the species composition in population, predominant species, frequency of occurrence, their abundance and species size, weight and numbers.

3.2.2 Result

(1) Sampling site characteristics

The characteristics of the 10 sampling sites as shown in Figure 3.1 are as follows.

- Kok River (Station 1 and 2) :
0.8-3.0 m deep, 100-120 m wide, with high flow and turbid water.
- Mae Loi River (Station 3 and 4) :
1-2 m deep, 8-12 m wide, stagnated turbid water.
- Ing River (Station 5 and 7) :
1.0-1.5 m deep, 30 m wide, stagnated and turbid water.
- Laos River (station 6) :
2 m deep, 20 m wide, low flow and turbid water.
- Yod River (Station 8) :
0.5 m deep, 15 m wide, clear water and flow.
- Yao River (Station 9) :
35 m wide, low flow and turbid.
- Nan River (Station 10) :
0.6 m deep, 50 m wide, low flow and turbid water.

(2) Findings from Sampling

1) Fish

A total of forty two (42) fish species were found in five (5) sampling stations including twelve (12) families as showing in Table 3.4.

The family Cyprinidae was the most abundant with 12 species followed by Cobitidae of 11 species and Bagridae and Mastacembelidae of 3 species each.

The number of species and total weight of fish at each sampling station are as follows.

River	family	species	size range (cm)	tails	total weight (grams)
Kok	4	7	1.5-17.5	281	302
Laos	7	20	n.a.	166	288
Ing	5	16	2.2-17.0	726	823
Yod	6	14	1.5-13.0	302	270
Nan	8	12	1.5-21.0	158	522

2) Plankton organisms

Plankton organisms collected from the 10 stations consisted of 5 of phytoplankton and 4 phylum of zooplankton. Phytoplankton are Bacillariophyta with 13 species, Chlorophyta with 12 species, Cyanophyta with 6 species, Euglenophyta with 1 species and Pyrrophyta with 2 species. Zooplankton groups are Rotifera with 10 species, Protozoa with 4 species, Arthropoda with 8 species and Nematoda with 1 species.

3) Benthic animals

Three phyla of benthic animals are found. The number of families and species found in each phyla were 2 families with 2 species of Annelida, 13 families with 12 species of Arthropoda, and 6 families with 10 species of Mollusca.

4) Aquatic plant

There are 12 families of aquatic plants found with a total of 15 species. They are 2 species of floating plants, 5 species of submerged plants, 2 species of emerged plants and 6 species of marginal plants.

(3) Preliminary Impact on Aquatic Ecology/Fishery

Based on the preliminary study on the aquatic ecology and fishery, the initial impacts due to the Kok-Ing-Nan Project are envisaged as follows:

- The diversion of water from one watershed to other watersheds will impose only low impact on the distribution of fish population because the same groups of fish with no violent behavior, and the same foliage and carnivore fish ratio are found.
- The aquatic ecosystem in the diversion tunnel may be changed at a high level due to a decrease in water temperature, oxygen consumption and no light.
The impact levels of Alternative A, B and C will not be different.
- The distribution of aquatic plants, especially Giant Minosa, will be affected at a moderate level.
- Other impacts will occur during the construction period in terms of an increase in sediment in surface water near the construction site.

Table 3.1
Quality of Water in Kok-Ing-Nan (May 1996)

Parameters	Unit	Station									
		Kok		Ing					Nan		
		1	2	3	4	5	6	7	8	9	10
Transparency	cm	14	15	38	19	12	30	22	>27	-	49
Flow rate	m ³ /s	-	50.8	-	-	-	8.39	15.2	0.88	2.67	-
Air Temperature	°C	29.4	27.6	-	-	-	-	-	31.3	30.3	31.0
Water Temperature	°C	30.3	28.4	34	33	33	32	31	26.5	28.9	27.8
Velocity	m/s	0.64	0.71	-	-	4.9	0.23	0.5	0.83	0.28	-
Depth	m	0.95	0.85	-	-	1.26	-	0.88	0.19	0.69	1.29
pH		8.0	8.2	7.5	7.6	7.7	7.8	7.6	7.9	8.1	8.2
Conductivity	μs/cm	154	158	174	124	146	153	146	224	230	257
TH	mg/l CaCO ₃	54	50	58	36	36	58	52	92	96	98
DO	mg/l	6.0	6.8	6.7	6.0	6.3	6.2	6.2	7.4	7.0	6.6
COD	mg/l	12	35	13	25	10	8.7	6.1	1.7	23	4.0
BOD	mg/l	1.0	0.8	2.7	4.9	1.9	0.9	0.2	0.7	1.0	0.7
NO ₃ -N	mg/l	0.23	0.23	0.53	0.26	0.21	0.03	0.19	0.15	0.2	0.09
TP	mg/l	0.36	0.20	0.09	0.33	0.51	0.16	0.04	0.01	0.03	0.06
NH ₃ -N	mg/l	0.22	0.20	0.04	0.32	0.27	0.11	0.08	0.03	0.04	0.07
TS	mg/l	188	309	131	160	252	142	148	118	112	133
DS	mg/l	88	70	99	110	147	87	79	113	103	115
SS	mg/l	100	239	32	50	105	55	69	5	9	18
Cl-	mg/l	1.6	1.6	2.6	2.6	4.1	1.6	1.0	0.5	1.0	2.6
SO ₄ ⁻²	mg/l	8.4	7.9	6.2	8.8	10.8	6.9	6.6	5.1	5.2	5.8
Total Coliform	MPN/100 vel	700	1,700	500	1,100	260	3,000	170	90	90	90
Fecal Coliform	MPN/100 vel	500	800	500	1,100	80	2,400	170	60	40	90

Table 3.2
Heavy Metal Level In Kok-Ing-Nan (May 1996)

(Unit: mg/l)

Station	Items								
	Pb	Cd	Cr	Hg	As	Ca	Mg	Fe	Mn
1	0.007	0.003	0.002	<0.002	0.003	8.61	3.94	1.54	0.14
2	0.006	0.002	<0.002	<0.002	0.002	8.73	4.09	2.39	0.28
3	0.006	<0.002	<0.002	<0.002	<0.002	8.18	4.4	0.19	0.22
4	0.004	0.002	0.002	<0.002	0.002	5.21	2.37	1.00	0.42
5	0.004	<0.002	<0.002	<0.002	<0.002	6.48	2.4	2.54	0.41
6	0.005	<0.002	0.002	<0.002	0.002	11.88	2.8	0.92	0.11
7	0.004	0.003	<0.002	<0.002	0.003	10.61	2.8	0.86	0.06
8	0.003	<0.002	<0.002	<0.002	<0.002	19.09	3.54	0.35	0.08
9	0.004	0.002	<0.002	<0.002	<0.002	19.94	4.06	0.39	0.05
10	0.004	<0.002	<0.002	<0.002	<0.002	18.79	4.62	0.35	0.08

Table 3.3
Organochlorine In Kok-Ing-Nan (May 1996)

(Unit: μ g)

Chemicals	Station	Sampling Station									
		1	2	3	4	5	6	7	8	9	10
Dieldrin		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Aldrin		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
BHC		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Heptachor		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Endrin		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
DDT		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

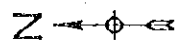
Table 3.4 (1/2)
Species of Fish Found in the Samples Collected from
Kok-Ing-Nan Rivers during May 27-28, 1996

Family /Scientific Name	Thai Name	Sampling Station				
		2	6	7	8	10
1. Cyprinidae (17=40.49%)						
<i>Barilius quttatus</i>	Nang oar	X	-	-	-	-
<i>Epalzeorhynchus coatesi</i>	Soi dok yang	X	-	-	-	-
<i>Barilius nanensis</i>	Nam muk	-	X	-	-	X
<i>Cirrhinus jullieni</i>	Soi kao	-	X	X	-	-
<i>Cyclocheilichthys armatus</i>	Pak lium	-	X	X	-	-
<i>Epalzeorhynchus siamensis</i>	Leb mue nang	-	X	-	-	-
<i>Esomus metallicus</i>	Siew nuard yao	-	X	X	-	-
<i>Labeo erythrurus</i>	Gar dang	-	X	X	-	-
<i>Labiobarbus lineatus</i>	Sar	-	X	X	-	-
<i>Mystacoleucus marqinatus</i>	Hang luang	-	X	X	-	X
<i>Osteochilus vittatus</i>	Rong mai tub	-	X	X	-	-
<i>Puntius ticto</i>	Tum	-	X	-	X	X
<i>Rasbora palustris</i>	Siew	-	X	X	-	-
<i>Morulus chrysophekadion</i>	Ga dum	-	-	X	-	-
<i>Garra teaniaia</i>	Lia hin	-	-	-	X	-
<i>Rasbora borapetensis</i>	Siew hang dang	-	-	-	X	-
<i>Hampala macrolepidota</i>	Kar sub ked	-	-	-	-	X
2. Cobitidae (11=26.19%)						
<i>Acanthopsis choirohynchus</i>	Rark kluay	X	X	X	-	-
<i>Botia cos</i>	Mum	-	X	-	-	-
<i>Cobitophis anquillaris</i>	Ard	-	X	X	-	-
<i>Botia hymenophysa</i>	Mum	-	-	X	-	-
<i>Nemacheilus binotatus</i>	Khor	-	-	-	X	X
<i>N. menanensis</i>	Khor	-	-	-	X	-
<i>N. nicholsi</i>	Khor	-	-	-	X	-
<i>N. redei</i>	Khor	-	-	-	X	-
<i>N. pallidus</i>	Khor	-	-	-	X	-
<i>N. multifasciatus</i>	Khor	-	-	-	X	-
<i>N. poculi</i>	Khor	-	-	-	X	-

Table 3.4 (2/2)
Species of Fish Found in the Samples Collected from
Kok-Ing-Nan Rivers during May 27-28, 1996

Family /Scientific Name	Thai Name	Sampling Station				
		2	6	7	8	10
3. Baqridae (3=7.14%)						
Mystus nemurus	Kod luang	X	-	X	-	-
Leiocassis siamensis	Kayaeng hin	X	X	-	-	-
Mystus cavasius	Kayaeng bai kwai	-	X	X	-	-
4. Channidae (1=2.38%)						
Channa striata	Chon	X	-	X	-	-
5. Centropomidae (1=2.38%)						
Chanda siamensis	Pan khaew	-	X	X	-	X
6. Pristolepidae (1=2.38%)						
Pristolepis fasciatus	Mom chang yeab	-	X	-	X	X
7. Anabantidae (1=2.38%)						
Trichopsis vittatus	Krim	-	X	-	-	-
8. Mastacembelidae (3=7.14%)						
Macrognathus siamensis	Load	-	X	-	-	X
Mastacembelus maculatus	Khar thing	-	-	-	X	-
Mastacembelus armatus	Khar thing	-	-	-	-	X
9. Belontiidae (1=2.38%)						
Xenentodon cancila	Khar thunghae	-	-	-	X	X
10. Gobiidae (1=2.38%)						
Pseudoqubiopsis siamensis	Bou	-	-	-	X	-
11. Notopteridae (1=2.38%)						
Notopterus notopterus	Salad	-	-	-	-	X
12. Tetraodontidae (1=2.38%)						
Tetraodon leirus	Pukpao jud	-	-	-	-	X
Total 12 Families 42 species		6	20	16	14	12

Note : Sampling stations are shown in Figure 3.1



0 5 10 15 KM.
SCALE

ສັນຍາລັກສະນະ ເລັດເຊີມ :

- ===== ພາກສັນຍາລັກສະນະ ກວ້າງ / ດູວເຣັດ
DIVERSION CANAL / CULVERT
- ພາກສັນຍາລັກສະນະ ຕໍ່ສົ່ງ
DIVERSION TUNNEL
- ◆ ເຂັ້ມ
DIVERSION STRUCTURE
- ຫົວປ່າ
HEAD REGULATOR
- ◎ ກຸ່ມ, ນະຄອນ
PROVINCE, DISTRICT
- ພາກສັນຍາລັກສະນະ ທາງຊາດ
NATIONAL BOUNDARY
- ພາກສັນຍາລັກສະນະ ທາງເມັດ
PROVINCIAL BOUNDARY
- ~~~~~ ພາກສັນຍາລັກສະນະ ນໍ້າ
RIVER, STREAM

▲ SURFACE WATER SAMPLING STATIONS

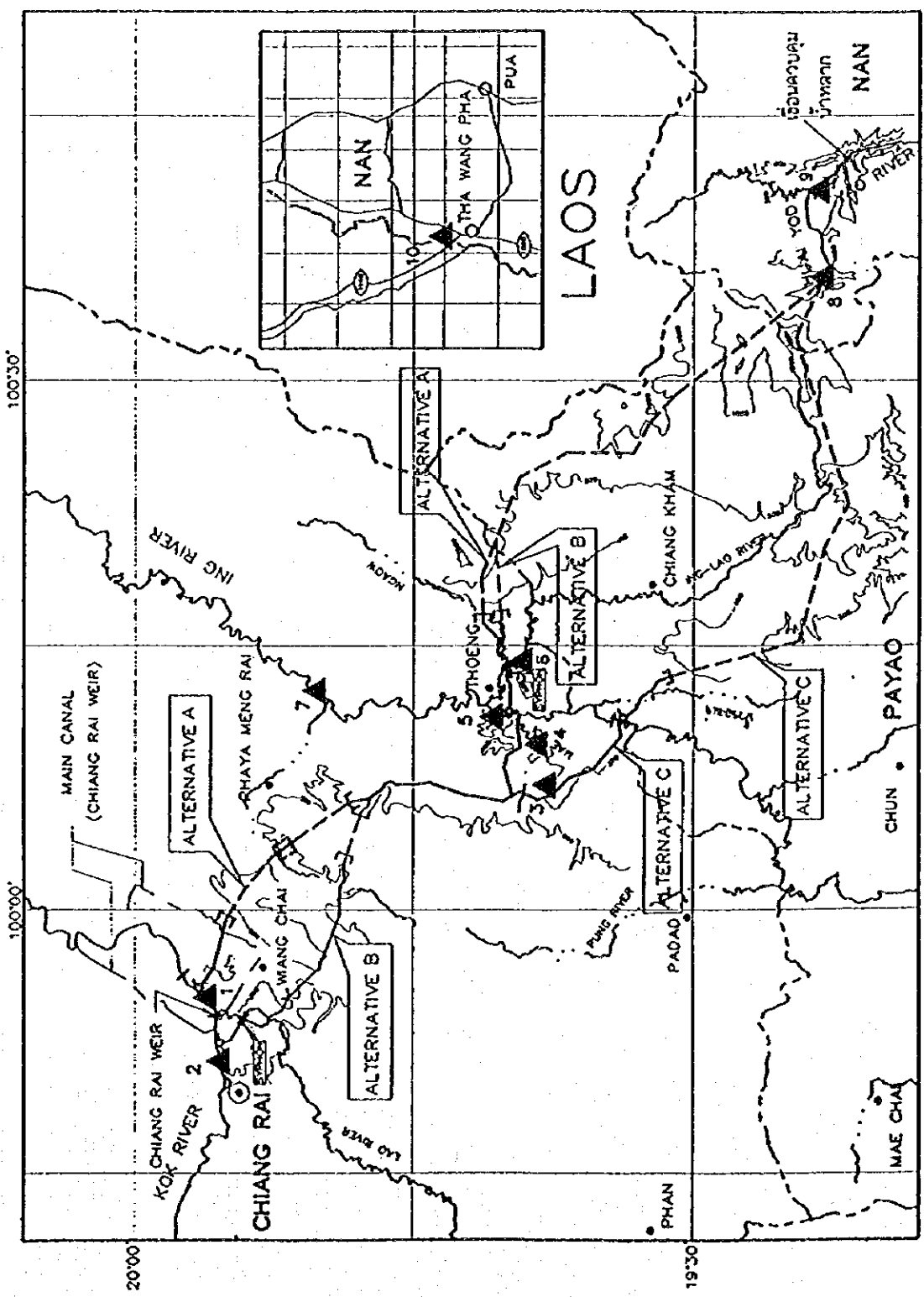


Figure 3.1 Surface Water Sampling Stations



CHAPTER 4 SOIL AND LAND USE

4.1 Methodology

An analysis on soil and land use was conducted based on the data collected from the Department of Land Development and other sources as well as findings from the field trip.

4.2 Results

4.2.1 Present Condition

Present conditions of soil and land use are shown in Table 4.1 and summarized as follows.

Soils

- No saline soils exist in the project area.
- Soil erosion occurs on upland sloping areas where upland annual crops are grown and shifting cultivation are practiced.
- Erosion by water is severe during heavy rain in the monsoon season leading to lower vegetation on surface.
- Nutrient decline is caused by product and plant residue removal, especially when coupled with imbalance in nutrients lost and added by fertilizers.

Land Use

- Lowland and flat areas are mostly paddy fields.
- Upland crops are grown in upland areas with gentle slope.
- Foothill areas are covered with disturbed forests, bushes and upland crops.
- Hills and mountainous areas are mainly natural forests, disturbed forests and shifting cultivation areas.

The major problems in soils and land use aspect are as follows.

- Nutrient removal by crops in paddy fields
- Severe soil erosion, especially during heavy rainfall in the rainy season, in upland soils. Soil degradation accelerated by soil nutrient removal.
- Soil erosion and land slide during heavy rain on hill slopes and mountains.

4.2.2 Comparison of Alternatives

(1) Factors to be Considered

Impacts of the project on soils and land use are analyzed for the areas on both sides of the prepared canals, 5 to 10 km each along the alignments A, B and C. Since no soil salinity is found in the project area, the analysis does not cover it. The factors to be considered in selecting alternative route alignments are soil erosion, nutrient depletion and land use types. Eroded soils are difficult to recover and it would require a great deal of investment and work. Nutrient removal and depletion is easier to cope with and improvement is possible through modifications in cropping systems, crop calendar and fertilizer application. Recovery of soil nutrient depletion can be achieved faster than that for soil erosion.

(2) Without Project Condition

(a) Soil Resources

Soils along the diversion alignment will be under crop production. Soils on lowland will be under paddy, whereas upland be under upland annual crops. Soil depletion will slowly proceed. The depletion rate of upland soils is faster than that in the lowland areas due to both erosion and nutrient removal. The upland soils will be shallow and contain rocks and stone fragments on the surface and hence have low water holding capacity. In a long period these areas may be no longer possible to support crop production. Soils on footslopes and hills are subject to erosion when forests are removed and the lands are converted to shifting cultivation.

(b) Land Use Types

The major land use type in the lowland areas will be paddy. Due to poor soil and crop management, and traditional practice, these areas will not change significantly. Land degradation, however, will lead to low yield of paddy. Upland crops on upland will drain soil and enhance soil erosion and nutrient depletion. Forests on foothills and hills will be encroached by shifting cultivation which will generate severe effects on environment.

(3) With Project Condition

The following conditions are envisaged under the with-project condition.

- Narrow strip soils will be permanently converted into the canal/culvert.

- Although the development of tunnels has no impact on soils and land use types on the hills, a large volume of rocks have to be removed from the tunnels. The impact of this development must be carefully evaluated.
- The paddy soils which are deep and suitable for agriculture found on flat topography will have no or very low soil erosion.
- On upland areas where soils are deep and well drained on gentle slope to undulating topography, soils can be easily eroded by rainwater. Upland crops are planted in rainy season which cause soil erosion and nutrient removal. This type of soil degradation, once takes place, would take long time for recovering.
- The upland areas on foothills comprise shallow and stony and gravel soils on undulating to rolling topography. The land use types are upland annual crops and disturbed forest or shifting cultivation. Soil erosion and nutrient removal are severe and rapid.

Alternative A of the Kok-Ing area will generate a higher degree of adverse impacts on soils and land use than Alternatives B and C, since the alternative A comprises four tunnel inlets and outlets at foothills, while the alternative B and C have only 1 inlet and outlet each. Higher level of soil erosion is likely under Alternative A since the route runs through upland areas.

For the Ing-Nan portion, no serious damage is expected to occur in either case. Since most portion of the alignments are tunnel, impacts on soil and land use will be minimal. Areas to be affected will be limited to small areas in and around the diversion canal and siphon, tunnel inlet and outlet and vertical shafts.

4.3 Work Items for EIA

In order to carry out a detailed EIA for a selected canal, the following information need to be collected.

- Detailed soil information along the alignment. The primary information includes morphology and physical and chemical characteristics.
- Detailed current land use types along the canal and tunnel.
- Information on agriculture.

Table 4.1 (1/3)

Soil and Land Use Characteristic Along the Diversion Alternatives

Kok-Ing-Nan Project

Alternative	Soils	Land Use
Alternative A		
1. From #1 ↓ 8.5 km.	Paddy soils, flat, deep and poorly drained soils	Agriculture, paddy
2. Ban Doi Kaew, hillslope ↓ 7 km (tunnel)	Upland and hilly soils, well drained	Degraded forest, upland crops
3. Tak river, HW.1152 ↓ 1.5 km.	Paddy soils, flat, deep and poorly drained soils	Paddy, agriculture
4. Tunnel 7 km. ↓	Upland and hilly soils	Degraded forest, upland crops
5. Doi Hom Hae, Inlet tunnel ↓ 2.5 km.	Paddy soils, flat, deep and poorly drained soils	Agriculture, paddy
6. AB ↓ 14.5 km.	Paddy soils, flat, deep and poorly drained soils	Agriculture, paddy
7. A ₁ B ₁ ↓ 5.5 km.	Paddy soils, flat, deep and poorly drained soils	Agriculture, paddy
8. Head Regulator ↓ 2 km.	Paddy and upland, deep to shallow, undulating	Paddy, upland crops, orchard
9. A ₂ B ₂ ↓ 5 km.	Shallow soils, hilly	Degraded forest /, shifting agriculture
10. Inlet A ↓ 7 km.	Paddy soils and upland soils	Paddy on lowland upland crops on upland soils
11. A ₃ B ₃	Hilly, shallow soils	Degraded forest, shifting agriculture
	Hilly, shallow soils	Degraded forest, shifting agriculture

Table 4.1 (2/3)

Soil and Land Use Characteristic Along the Diversion Alternatives
Kok-Ing-Nan Project

Alternative	Soils	Land Use
Alternative B		
1. Head Regulator B (Kok River) ↓ 27 km.	Mostly paddy soils, small areas of upland soils, flat deep soils	Paddy, upland crops, agriculture
2. Inlet tunel ↓ 4 km	Shallow soils on hills	Degraded forest
3. Outlet tunnel ↓ 2.5 km.	Paddy soils, flat, deep and poorly drained soils	Paddy, agriculture
4. AB ↓ 14.5 km.	Paddy soils, flat, deep and poorly drained soils	Paddy, agriculture
5. A ₁ B ₁ ↓ 5.5 km.	Paddy soils, flat, deep and poorly drained soils	Paddy agriculture
6. Head Regulator A/B (Ing River) ↓ 2 km. 4 km.	Paddy soil, upland, deep to shallow, undulating	Paddy, upland crops, orchard
7. A ₂ B ₂ ↓ 5.5 km.	Shall soils, hilly Paddy soil and upland soils	Degreaded forest, shifting agriculture Paddy on lowland, upland crops on upland soils
8. Inlet B ↓ 7 km. A ₃ B ₃ ↓ A ₂ B ₂ ↓ 4.6 km.	Hilly, shallow soil Hilly, shallow soil	Degraded forest, shifting agriculture Degraded forest, shifting agriculture
9. Ban Pha Lak		

Table 4.1 (3/3)

Soil and Land Use Characteristic Along the Diversion Alternatives

Kok-Ing-Nan Project

Alternative	Soils	Land Use
<p>Alternative C</p> <p>1. Head Regulator B (Kok River) 48 km. ↓ A₁B₁ 15 km. ↓ 2. Inlet river, (Head Regulator) 7 km ↓ Inlet C 5 km ↓ 3. Ban Pha Lad 7.5 km. ↓ 4. Ban San Pa Sak 38 km. ↓ 5. Huai Yot Ban Pha Lak</p>	<p>Same as Alternative B</p> <p>Paddy soils, flat, deep and poorly drained soils</p> <p>Paddy and upland soils, flat to undulating, deep soils</p> <p>Shallow soil on hills</p> <p>Upland soils, undulating, deep and well drained</p> <p>Shallow soils on hills</p>	<p>As same as Alternative B</p> <p>Paddy, agriculture</p> <p>Paddy on lowland, upland crops on upland</p> <p>Upland crops</p> <p>Upland crops</p> <p>Degraded forest, shifting agriculture</p>